DOCUMENT RESUME

ED 301 675 CE 051 414

TITLE	Industrial Arts Instructional Tasks/Competencies for Energy and Power. Competency-Based Education.
INSTITUTION	George Mason Univ., Fairfax, Va.; Henrico County Public Schools, Glen Allen, VA. Virginia Vocational Curriculum Center.
SPONS AGENCY	Virginia State Dept. of Education, Richmond. Div. of Vocational and Adult Education.
PUB DATE	85
CONTRACT	VA-82-C-AD001
NOTE	132p.; For related documents, see CE 051 005 and CE 051 406.
AVAILABLE FROM	Virginia Vocational Curriculum and Resource Center, 2200 Mountain Road, Glen Allen, VA 23060-2208 ($7.05).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Behavioral Objectives; Competency Based Education; *Course Content; Criterion Referenced Tests; Curriculum Development; Electric Motors; *Energy; Engines; *Industrial Arts; *Job Skills; *Power Technology; Task Analysis

ABSTRACT

This instructional task/competency package is designed to help teachers and administrators in developing competency-based instructional materials for an energy and power course. Part 1 contains a description of the industrial arts program and a course description, instructional task/competency list, and content outline for energy and power. The task/competency list includes the minimum tasks/competencies identified for inclusion in the course, listed in a suggested order of instruction. The content outline corresponds with the task/competency list in content and sequencing. However, within the outline, tasks are identified in topical form and related tasks are grouped into broader topics of instruction. Part 2 contains information in each of the tasks/competencies identified in Part 1. The following information is provided for each task/competency: appropriate program and course designation, performance and enabling objectives, a criterion-referenced measure, and suggested activities and aids for instruction. The six major content/concept areas for energy and power into which the tasks/competencies are grouped are introducing power, exploring thermal power, exploring pneumatics, exploring hydraulics, exploring electric motors, and exploring motor controls. Appendixes include listings of information and resources and of audiovisual materials. (YLB)

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Industrial Arts Instructional Tasks/Competencies for Energy and Power

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COMPETENCY-BASED CBE EDUCATION

GUIDE APPLICATION

This publication has been prepared for use in developing instructional materials and in implementing competency-based education for the following program and course:

Program	Course
Industrial Arts (CIP Code: 21.0105)	Energy and Power (VA. 8448)

Because of the nature of this course, no specific career, occupational, or vocational applications of energy and power competencies are identified. Energy and Power, like other Industrial Arts courses, is intended to provide for students an orientation to a wide range of occupations and to assist them in assessing their talents and interests and in clarifying their career goals.

Additional information concerning the application and use of this publication in program planning and development should be addressed to:

Industrial Arts Education Service
Vocational and Adult Education
Department of Education
P.O. Box 6Q
Richmond, Virginia 23216

INDUSTRIAL ARTS

INSTRUCTIONAL TASKS/COMPETENCIES

FOR

ENERGY AND POWER

Developed by

Virginia Vocational Curriculum Center
Department of Vocational and Community Education
Henrico County Public Schools
Glen Allen, Virginia 23060

and

George Mason University
Fairfax, Virginia 11030

In Cooperation With

Commonwealth of Virginia
Department of Education
Vocational and Adult Education
Richmond, Virginia 23216

This publication was developed for the Virginia Department of Education, Divisions of Vocational and Adult Education under the provisions of the Vocational Education Amendments of 1976, (Public Law 94-482) and Competency-Based Education Project Contract (#VA-82-C-AD001) awarded to George Mason University.

1985

FOREWORD

Competency-based education (CBE) provides a means for allowing students and teachers to assess learning in relation to competencies and specific objectives set forth in advance.

Although nonoccupational in focus, this publication adheres to the CBE practice of recording competencies developed by students. This practice permits the smooth transition to an occupational track at a later time, if the student wishes.

Competency-based education is being implemented in Virginia to prepare students to enter the work force or to effect a smooth transition between secondary and post-secondary programs when both levels of education are required for career training. In addition, CBE is increasingly effective in retraining workers who have been displaced because of changing technology.

This publication will assist teachers and administrators in developing instructional materials that meet the needs of students and industry and comply with the Virginia CBE standards for vocational and adult education.

S. John Davis
Superintendent of Public Instruction

Dewey T. Oakley, Jr.
Acting Administrative Director
Vocational and Adult Education

ACKNOWLEDGMENTS

This task/competency package was accomplished in two phases. Phase 1 consisted of original task list composition and validation, analyses of those tasks, and field testing, under the direction of Dr. John Bonfadini of George Mason University. The Phase 1 research and field-test team consisted of the following:

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Phase 2 of the project consisted of refinement and verification procedures, performed by Bob D'Agostino, Industrial Arts instructor, Denbigh High School; and the final production process, coordinated by Dr. Kay B. Brown, Vocational Curriculum Development Supervisor, Virginia Department of Education. The organization and editorial revisions necessary to prepare the manuscript for publication were performed by the Virginia Vocational Curriculum Center, administered by Henrico County Public Schools, Department of Vocational and Community Education:

Flora C. Armstrong, Director
Peggy Watson, Writer/Editor

Special recognition is given to the students of the Henrico Trade Center of the Henrico County Public Schools, Department of Vocational and Community Education. Under the supervision of William D. Burton, printing instructor, these students printed, assembled, packaged, and prepared the guide for distribution.

Dr. William M. Moore, Director
Division of Vocational Research and Adult Services
Virginia Department of Education

Thomas A. Hughes, Jr.
Associate Director
Industrial Arts Education
Virginia Department of Education

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INTRODUCTION

This instructional task/competency package is designed to be used in combination with the Industrial Arts Guide to CBE Implementation in order to implement competency-based education in the course Energy and Power. The implementation guide contains information that pertains to all courses within the industrial arts area; the sections of that publication are titled Career Decision-Making Information, Student Organization (AIASA), Classroom Management Systems, and Recording Systems. This task/competency package contains suggested task sequence list, content outline, and task/competency information for the specific course, Energy and Power. Detailed instructions for combined use of these two publications are contained within the Industrial Arts Guide to CBE Implementation.

Using the Task/Competency Package

Part 1 contains a description of the Industrial Arts program and a course description, instructional task/competency list, and content outline for Energy and Power. The task/competency list includes the minimum tasks/competencies identified for inclusion in the course, listed in a suggested order of instruction. The content outline corresponds with the task/competency list in content and sequencing. However, within the outline, tasks are identified in topical form and related tasks are grouped into broader topics of instruction.

Part 2 contains information for instruction in each of the tasks/competencies identified in Part 1. The following information is provided for each task/competency: appropriate program and course designation, performance and enabling objectives, a criterion-referenced measure, and suggested activities and aids for instruction.

It is suggested that the Part 1 task sequence list and course content outline be reviewed initially so that any additional tasks may be added, any extraneous tasks may be deleted, and any desired changes in sequencing of instruction be made. Once the sequencing is confirmed, lesson planning and implementation may proceed through referral to the Part 2 task/competency sheet noted beside each instructional topic within the outline.

PART 1

PROGRAMS AND COURSES

The course description, content outline, and suggested task sequence contained in this section were developed using the validated task inventory presented in Part 2 of this guide. The program and course have been approved by the Virginia Department of Education.

The course outline has been cross-referenced with the task/competency information sheets to assist the teacher in identifying instructional objectives, materials, criterion standards, and reference materials.

OVERVIEW OF INDUSTRIAL ARTS EDUCATION PROGRAMS[1]

The Industrial Arts Education offerings are provided to assist the student in developing an understanding about industry and technology and in the discovery and development of individual potential. There are two types of industrial arts programs designed for the secondary school level:

1. Orientation and Exploration--designed for grades 7 through 9, this program assists students in making informed and meaningful occupational and educational choices. The program, designed for the middle or junior high school, provides the student with a broad base of try-out experiences and insights into career opportunities. It gives a basis for personal assessment of work interests and aptitudes. Instruction at this level places emphasis upon the following:

   a. Using the tools, equipment, materials, and products associated with industry and technology

   b. Role playing in simulated enterprises associated with a number of the career clusters

   c. Studying and analyzing the materials, products, processes, problems, uses, developments, and contributions of many of the elements making up career clusters

   d. Studying the organization of numerous industries or businesses while experiencing typical aspects of many

   e. Researching, planning, designing, constructing, evaluating, and generalizing in association with problems and projects related to various career clusters.

2. Technical Adaptability--designed for grades 9 through 12, this program prepares students for vocational and technical career decisions. The senior high school program provides students with competencies which will result in an occupational readiness and responsible citizenship useful for the future craftsperson, technician, engineer, or consumer. It provides a foundation for career preparation either at the secondary or postsecondary level. The senior high program complements the middle or junior high school offering by completing a sequence of opportunities to learn about the industrial and technological aspects of society. Instruction in the program places emphasis upon the following:

   a. Preparing for enrollment in advanced technical or occupational programs

   b. Understanding industry and technology and their place in society and the free enterprise system

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[1]Division of Program Services and Division of Administrative Services and Continuing Education, Vocational Education Student Planning Guide (Richmond: Virginia Department of Education).

c. Understanding industrial processes and the practical application of scientific principles

d. Developing basic skills in the proper use of common industrial tools, materials, and processes

e. Solving problems creatively, using the materials, processes, and products of industry.

Activities of the American Industrial Arts Student Association (AIASA) are included as a part of the instructional program to promote leadership qualities, high standards of work performance, scholarship, and safety. Teachers integrate AIASA experiences within their instruction by providing students with the following:

a. An involvement with the community's industrial and technical resources

b. Activities in parliamentary procedures and democratic decision-making

c. Recognition for exemplary performance, work skills, and safety procedures.

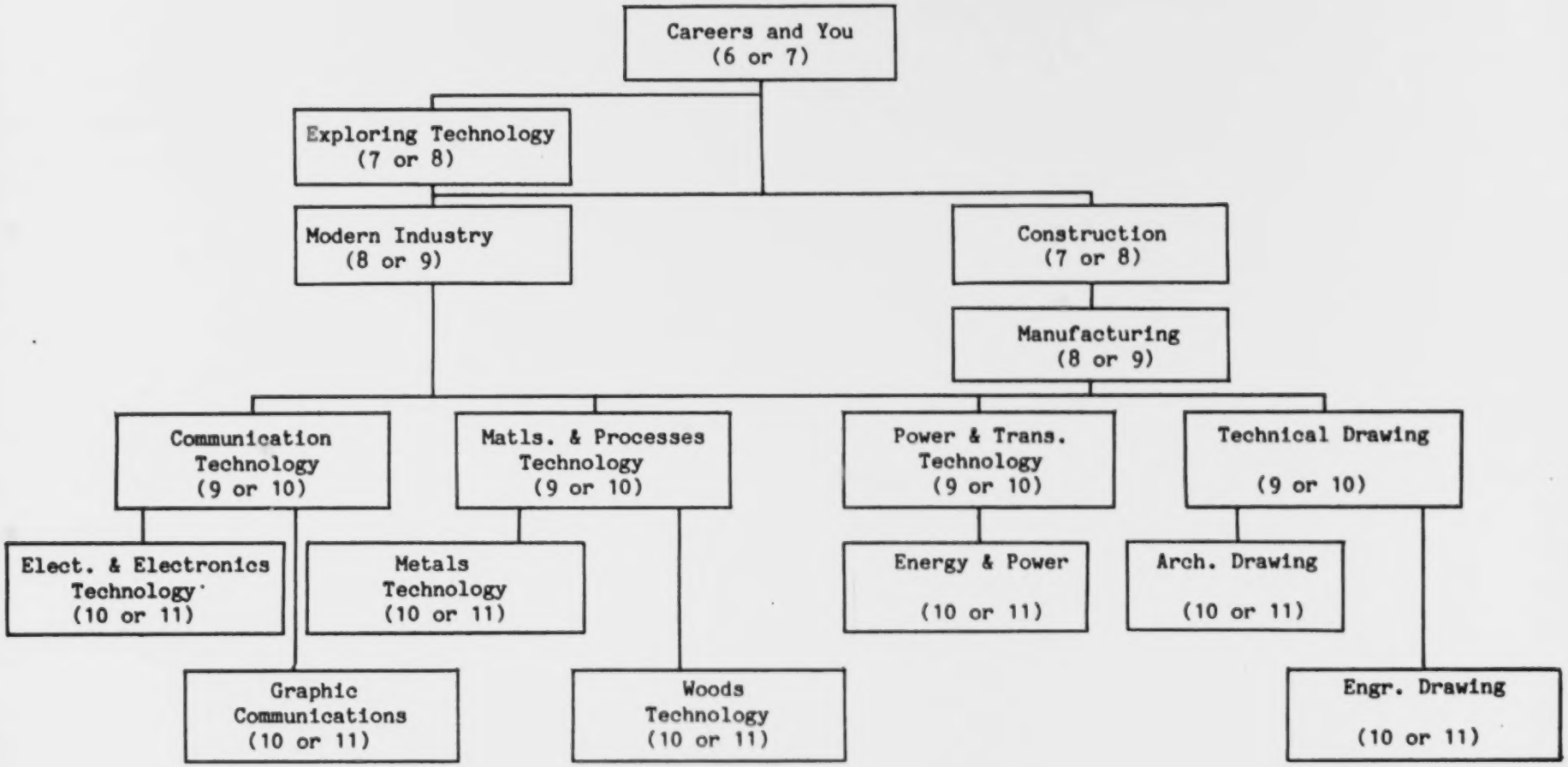
THE INDUSTRIAL ARTS CURRICULUM

LEVEL	GOAL	PROGRAM
Elementary School	Learning Reinforcement	Industrial Arts activities integrated within the elementary curriculum
Middle or Junior High School	Orientation and Exploration	Exploring Technology Modern Industry Construction Manufacturing
High School	Technical Adaptability	<u>Phase I</u> Basic Technical Drawing Communication Technology Materials and Processes Technology Power and Transportation Technology <u>Phase II</u> Architectural Drawing Electricity and Electronics Technology Energy and Power Engineering Drawing Graphic Communications Metals Technology Woods Technology

INDUSTRIAL ARTS EDUCATION PROGRAMS

PROGRAMS	AVAILABLE COURSES	CODE	SUGGESTED GRADE	NO. WEEKS
Occupational Orientation (Pre-exploratory)	A World of Choice: Careers and You	8475	6 or 7	36 or 18
Orientation and Exploration	Exploring Technology (18 or 36 weeks)	8464	7, 8, or 9	18
		8461	7, 8, or 9	36
	Modern Industry (18 or 36 weeks)	8463	7, 8, or 9	18
		8462	7, 8, or 9	36
	Construction (18 or 36 weeks)	8432	7, 8, or 9	18
		8431	7, 8, or 9	36
	Manufacturing (18 or 36 weeks)	8426	7, 8, or 9	18
		8425	7, 8, or 9	36
Technical Adaptability	Communication Technology	8415	9 or 10	36
	Materials and Processes Technology	8433	9 or 10	36
	Power and Transportation Technology	8445	9 or 10	36
	Basic Technical Drawing	8435	9 or 10	36
Technical Adaptability (Phase Two)	Architectural Drawing	8347	10 - 12	36
	Electricity & Electronics Technology	8416	10 - 12	36
	Energy and Power	8448	10 - 12	36
	Engineering Drawing	8436	10 - 12	36
	Graphic Communications	8458	10 - 12	36
	Metals Technology	8439	10 - 12	36
	Woods Technology	8449	10 - 12	36
Alternative (Vocational Centers)	Industrial Occupational Exploration (ICE)	8472	9 or 10	36

SUGGESTED SEQUENCES OF OFFERINGS*
INDUSTRIAL ARTS EDUCATION



*This chart is recommended for student guidance and is used to suggest best sequence of courses.

THE INDUSTRIAL ARTS COURSE IN ENERGY AND POWER

COURSE DESCRIPTION: Energy and Power is a course designed to provide students with a general knowledge of the basic principles of power and energy. Through hands-on laboratory experiences, the student will conduct activities associated with: thermal power engines, hydraulic and pneumatic systems, electrical motors and controls, and diesel and marine outboard engines. Maintenance and repair activities will center on small gasoline engines. Other sources of energy will be included as part of this course.

PREREQUISITES: None

SUGGESTED GRADE LEVEL: 9, 10, 11, 12

Task/Competency Sequence

1.1 Define terms used in power systems
1.2 Construct a mechanical power system
1.3 Troubleshoot and repair a malfunctioning electrical system
1.4 Identify fluidal system components
1.5 Explain how thermal energy is used in engines
1.6 Participate in an organized personnel system to manage class and laboratory activities
2.1 Identify the major subsystems of the automobile engine
2.2 Compare diesel and gasoline engine operating principles
2.3 Explain the function of fuel system components
2.4 Adjust and set ignition timing
2.5 Maintain and service a cooling system
2.6 Identify the major components of a transmission
2.7 Trace the transfer of energy through a power train
2.8 Select oil by grade, weight, and additive
2.9 Remove, inspect, reinstall or replace, and adjust ignition system components
2.10 Troubleshoot and isolate engine malfunctions
2.11 Explain the functions of the major subsections of a gas turbine engine
2.12 Identify major subsystem components of a diesel engine
2.13 Identify the major operational systems of an outboard engine
2.14 Identify community and technical resources
3.1 Construct a simple pneumatic circuit
3.2 Construct a complex pneumatic circuit
3.3 Construct a multifunction pneumatic circuit
4.1 Construct a controlled hydraulic delay circuit
4.2 Construct a hydraulic delay circuit
4.3 Construct a multifunction hydraulic circuit
5.1 Identify sizes and types of electric motors
5.2 Determine the working characteristics of a motor
5.3 Explain how a split-phase motor operates
5.4 Identify characteristics of the permanent split-capacitor motor
5.5 Construct a circuit containing a shaded pole motor
5.6 Identify the capacitor start/run motor by its physical characteristics

5.7 Explain the principles of operation of a series motor
5.8 Construct a circuit, using a three-phase motor
5.9 Explain electrical energy transfer through mutual induction in transformers
5.10 Participate in school or community improvement activities
6.1 Identify the controls used to start, stop, and reverse an electrical motor
6.2 Construct a motor speed control circuit
6.3 List the methods to control a motor by time or temperature
6.4 Construct a motor control, using a step-down transformer
6.5 Inspect, repair, and test an electrical motor
6.6 Participate in a group enterprise project
6.7 Participate in competitive events

ENERGY AND POWER

CONTENT OUTLINE		TASK/COMPETENCY CODE
I.	Introducing Power	
A.	Definition of terms	1.1
B.	Construction of mechanical power system	1.2
C.	Troubleshooting and repair of a malfunctioning electrical system	1.3
D.	Identification of fluidal system components	1.4
E.	Explanation of thermal energy use in engines	1.5
F.	Participation in an organized personnel system	1.6
II.	Exploring Thermal Power (Internal Combustion Engines)	
A.	Identification of major auto engine subsystems	2.1
B.	Comparison of diesel and gas engine operating principles	2.2
C.	Explanation of fuel system component functions	2.3
D.	Adjustment of ignition timing	2.4
E.	Maintenance and service on cooling system	2.5
F.	Identification of transmission system components	2.6
G.	Explanation of energy transfer through power train	2.7
H.	Selection of oil	2.8
I.	Service of ignition system components	2.9
J.	Identification of engine malfunctions	2.10
K.	Explanation of function of gas turbine engine major subsections	2.11
L.	Identification of major subsystem components of a diesel engine	2.12
M.	Identification of major operational systems of an outboard motor	2.13
N.	Identification of community and technical resources	2.14
III.	Exploring Pneumatics	
A.	Construction of simple pneumatic circuit	3.1
B.	Construction of complex pneumatic circuit	3.2
C.	Construction of a multifunction pneumatic circuit	3.3
IV.	Exploring Hydraulics	
A.	Construction of a controlled hydraulic circuit	4.1
B.	Construction of a hydraulic delay circuit	4.2
C.	Construction of a multifunction hydraulic circuit	4.3
V.	Exploring Electrical Motors	
A.	Identification of sizes and types of electric motors	5.1
B.	Description of working characteristics of a motor	5.2

CONTENT OUTLINE			TASK/COMPETENCY CODE
V.	C.	Explanation of split-phase motor operation	5.3
	D.	Identification of characteristics of permanent split-capacitor motor	5.4
	E.	Construction of shaded pole motor circuit	5.5
	F.	Identification of capacitor start/run motor	5.6
	G.	Explanation of series motor operation	5.7
	H.	Construction of a circuit, using a three-phase motor	5.8
	I.	Explanation of electrical energy transfer through mutual induction in transformers	5.9
	J.	Participation in school or community improvement activities	5.10
VI.	Exploring Motor Controls		
	A.	Identification of start, stop, and reverse electrical motor controls	6.1
	B.	Construction of a motor speed control circuit	6.2
	C.	Methods to control a motor by time or temperature	6.3
	D.	Construction of a motor control, using a step-down transformer	6.4
	E.	Inspection and repair of an electrical motor	6.5
	F.	Participation in a group enterprise project	6.6
	G.	Participation in competitive events	6.7

PART 2

TASK INVENTORY

One of the major characteristics of competency-based education (CBE) is that the course content is based upon actual jobs or tasks performed by persons living and working in the technological world. In Virginia, the Department of Education has established standards for competency-based education. According to these standards, competencies must be "role-relevant" and based upon "appropriate research." This standard states:

> Role-relevant competencies that include standards are identified and stated:
>
> The competencies with standards will be identified through V-TECS, IDECC, and other appropriate research. Advisory committees should be used to review competencies and standards. Competencies in the affective domain will be included. Role-relevant competencies are occupational preparation programs for those that specifically relate to the occupation for which the student is being prepared as well as to the personal needs of the student. Role-relevant competencies are related also to orientation, exploration, or industrial arts experiences which have been identified for students.

Therefore, "role-relevant" jobs or tasks, called competencies in CBE, must be identified and validated before instructional materials are developed and subsequent instruction can take plan.

The task list contained in this instructional guide was based on the following:

1. The Virginia Industrial Arts Education Competency Catalog for Energy and Power
2. The review and selection of appropriate competency-based materials
3. Input from industrial arts teachers and curriculum specialists.

Based upon the information collected and reviewed from the available sources indicated, a task inventory was prepared.

The next major step involved in the development of the task inventory was validation of the task list. Validation is essential if the information collected is to be useful in operating CBE courses and programs. The validation process involved the following:

1. Review by writing-team members to determine completeness of the inventory.
2. Review and validation by state consultants to ensure the role-relevance and completeness of the inventory.
3. Review by local industrial arts teachers to determine the validity of the inventory.
4. Final review and editing by writing-team members, project directors, and state staff.

The task list included in this publication was based on current available resources and validated by teachers, advisory committee members, and persons employed in industrial arts. Regional and local tasks were included in the inventory; therefore, individual tasks may or may not be applicable for a given locality. It is essential that all instruction be based on the validated task analyses included in this resource.

TASK INVENTORY FOR

ENERGY AND POWER

CONTENT / CONCEPT AREAS

1. Introducing Power
2. Exploring Thermal Power (Internal Combustion Engines)
3. Exploring Pneumatics
4. Exploring Hydraulics
5. Exploring Electric Motors
6. Exploring Motor Controls

CONTENT/CONCEPT

1. INTRODUCING POWER

TASKS/COMPETENCIES

1.1 Define terms used in power systems

1.2 Construct a mechanical power system

1.3 Troubleshoot and repair a malfunctioning electrical system

1.4 Identify fluidal system components

1.5 Explain how thermal energy is used in engines

1.6 Participate in an organized personnel system to manage class and laboratory activities

Application

CONTENT / CONCEPT

1. INTRODUCING POWER

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

1.1 Define terms used in power systems

COURSE

Energy and Power (8448)

1.1

PERFORMANCE OBJECTIVE

P1.1 Given a list of terms related to power and energy systems and necessary references, define the terms used in power systems with 100% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E1.1.1 Identify the basic terms associated with electricity, electrical controls, and motors.

E1.1.2 List terms used in mechanical energy, engines, and test equipment.

E1.1.3 Describe the basic physical science principles used in fluid power systems.

CRITERION-REFERENCED MEASURE

C1.1 Instructor-prepared quiz on power system terms, 100% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Compose a list of basic electrical terms (example: amp, watt, volt, ohm, current, electromagnets, shaded pole motors, permanent split-phase motor, series motor, etc.). Have students research the definitions (E1.1.1).

2. Have students define horsepower, cubic inch displacement, inch pound, foot pound, torque, and other terms that deal with mechanical energy, engines, and test equipment (E1.1.2).

3. Explain basic principles of fluid power, using diagrams and charts (E1.1.3).

4. Use a hydraulic trainer to show students how the components of a fluid power system function (E1.1.3).

SELECTED TOOLS AND MATERIALS

Hydraulic trainer
Open end wrenches
Scientific dictionary or other references with definitions of terms related to energy and power
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

Filmstrips/Cassettes: Introduction to Power. Prentice-Hall Media.

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

Application

CONTENT/CONCEPT

1. INTRODUCING POWER

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

1.2 Construct a mechanical power system

COURSE

Energy and Power (8448)

1.2

PERFORMANCE OBJECTIVE

P1.2 Given the necessary tools and materials, construct a mechanical power system that includes a lever, pulley, and a wheel and axle. Construction must meet instructor-prepared specifications.

SELECTED ENABLING OBJECTIVES

E1.2.1 Describe the relationship among simple machines, ratios, and force.

E1.2.2 List parts required to construct a simple mechanical system.

E1.2.3 Explain how thermal power is converted to mechanical power.

E1.2.4 Describe how mechanical power is integrated into other power systems.

CRITERION-REFERENCED MEASURE

E1.2 Mechanical power system constructed according to instructor-prepared specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students define lever, energy, force, pulley, block torque, and block and tackle (E1.2.1).

2. Construct and demonstrate use of a basic mechanical system, using the lever theory (example: fulcrum, block and tackle) (E1.2.2).

3. Have students define thermal power and explain how it is converted into mechanical power (example: operating principles of the reciprocating engine) (E1.2.3, E1.2.4).

SELECTED TOOLS AND MATERIALS

Open end wrenches
Levers
Fulcrums
Butcher's twine
Pulley system
Instructor-prepared specifications

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

Application

CONTENT/CONCEPT
1. INTRODUCING POWER

PROGRAM
INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY
1.3 Troubleshoot and repair a malfunctioning electrical circuit

COURSE
Energy and Power (8448)

1.3

PERFORMANCE OBJECTIVE

P1.3 Given the necessary equipment and resources and classroom instruction, troubleshoot and repair a malfunctioning electrical circuit with 100% accuracy according to instructor-prepared guidelines.

SELECTED ENABLING OBJECTIVES

E1.3.1 List the basic elements of an electrical circuit.

E1.3.2 Identify the components used to control electrical systems.

E1.3.3 Demonstrate proper and safe use of tools and equipment.

E1.3.4 Explain how to check, examine, and repair selected electrical equipment.

E1.3.5 Describe the operation of an electrical device that uses magnetism, light, or heat as its primary energy source.

CRITERION-REFERENCED MEASURE

C1.3 Malfunctioning electrical circuit analyzed and repaired with 100% accuracy according to instructor-prepared guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students define series and parallel circuits (E1.3.1).
2. Lead a class discussion on devices used to control electrical systems (E1.3.2).
3. Have students generate a list of safety rules to follow when using various hand and power tools (E1.3.3).
4. Demonstrate techniques used to troubleshoot electrical circuits (E1.3.4).
5. Define magnetic fields and discuss how magnetism is used in various electrical devices (E1.3.5).
6. Explain the operating principles of devices that use light and heat to create energy (examples: photocell, microwave wire) (E1.3.5).

SELECTED TOOLS AND MATERIALS

Electric motor
Nut driver
Screwdrivers, flat head
Soldering iron
Solder
Copper wire
Instructor-prepared guidelines

SELECTED AUDIOVISUAL MATERIALS

Filmstrip/Cassettes: Fundamentals of Electrical Power. Prentice-Hall Media.
Filmstrip/Cassette: Basic Electrical Circuits. Career Aids, Inc.

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

1. INTRODUCING POWER

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

1.4 Identify fluidal system components

COURSE

Energy and Power (8448)

1.4

PERFORMANCE OBJECTIVE

P1.4 Given the necessary classroom instruction and diagrams of fluidal systems, identify fluidal system components as hydraulic or pneumatic with 95% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E1.4.1 Define basic principles of fluid power.

E1.4.2 Explain the operation of a hydraulic system.

E1.4.3 Explain the operation of a pneumatic system.

E1.4.4 Identify applications of hydraulic and pneumatic power systems used in industry.

CRITERION-REFERENCED MEASURE

C1.4 Instructor-prepared quiz on fluidal system components, 95% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students define the principles of hydrodynamics, hydrostatics, atmospheric pressure, absolute and gauge pressure, and Pascal's Law (E1.4.1).

2. Use diagrams or illustrations to identify and explain the function of hydraulic and pneumatic system components (E1.4.2, E1.4.3).

3. Have students research and report on how hydraulic and pneumatic systems are used in industry (E1.4.4).

SELECTED TOOLS AND MATERIALS

Parts of hydraulic system
Parts of pneumatic system
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

Filmstrips/Cassettes: Fundamentals of Fluid Power. Prentice-Hall Media.

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

Application

CONTENT / CONCEPT

1. INTRODUCING POWER

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

1.5 Explain how thermal energy is used in engines

COURSE

Energy and Power (8448)

1.5

PERFORMANCE OBJECTIVE

P1.5 Given the necessary classroom instruction and access to an internal combustion engine, explain how thermal energy is used in an engine with 90% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E1.5.1 List the principles that apply when heating gases and burning fuels.

E1.5.2 Explain how gases are heated and expanded.

E1.5.3 Identify types of fuels used in engines.

E1.5.4 Explain how the fuels produce power to operate the engines.

CRITERION-REFERENCED MEASURE

C1.5 Instructor-prepared quiz on thermal energy in engines, 90% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Lead a class discussion on the different processes used in heating and expanding gases (E1.5.1, E1.5.2).

2. Have students develop a list of different types of fuels used to produce thermal energy (examples: gasoline, propane, diesel, solar, electrical) (E1.5.3).

3. Compare the operation of a four-cycle auto engine and a diesel engine and have students identify the differences due to type of fuel used (E1.5.3, E1.5.4).

SELECTED TOOLS AND MATERIALS

Internal combustion engine
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.
Small Engines. Volumes I and II. AAVIM.

Application

CONTENT/CONCEPT

1. INTRODUCING POWER

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

1.6 Participate in an organized personnel system to manage class and laboratory activities

COURSE

Energy and Power (8448)

1.6

PERFORMANCE OBJECTIVE

P1.6 Given the list of in-class officers, committees, and the duties of each, participate in an organized personnel system to manage class and laboratory activities in accordance with AIASA and school policies.

SELECTED ENABLING OBJECTIVES

E1.6.1 List the reasons why people have organizations.

E1.6.2 Identify some of the organizations in school, community, and industrial settings.

E1.6.3 Describe the duties of officers and committees in the personnel system.

E1.6.4 Describe the necessary steps to perform each of the following personnel system activities:

a. Application for a position in the personnel system
b. Election of fellow students to positions in the system
c. Use of in-class agenda to conduct meetings.

CRITERION-REFERENCED MEASURE

C1.6 Participation in organized personnel system in accordance with AIASA and school policies.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Provide an overview of organizations, the different types, and the reasons for them (E1.6.1, E1.6.2).

2. Introduce students to the American Industrial Arts Student Association through literature and slides (E1.6.1-E1.6.3).

3. Hand out and discuss a listing of the duties of officers and committees in the personnel system (E1.6.3).

4. Have students establish a personnel system; have them apply for offices, conduct elections, and conduct meetings (E1.6.4).

SELECTED TOOLS AND MATERIALS

AIASA officer symbols
Flag, banner, and gavel

SELECTED AUDIOVISUAL MATERIALS

Film: How to Conduct a Meeting. Instructional Media/Technology, Virginia Department of Education. (#04606).

Slides: Move with Tomorrow. Industrial Arts Education Service.
Organizing the Industrial Arts Student Association. Industrial Arts Education Service.

SELECTED REFERENCES

Organizing the Industrial Arts Student Association, Guide 1. Industrial Arts Education Service.
Robert's Rules of Order. Henry M. Robert.
Student Association Activities in Industrial Arts, Guide 2. Industrial Arts Education Service.

CONTENT/CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

TASKS/COMPETENCIES

2.1 Identify the major subsystems of the automobile engine

2.2 Compare diesel and gasoline engine operating principles

2.3 Explain the function of fuel system components

2.4 Adjust and set ignition timing

2.5 Maintain and service a cooling system

2.6 Identify the major components of a transmission

2.7 Trace the transfer of energy through a power train

2.8 Select oil by grade, weight, and additive

2.9 Remove, inspect, reinstall or replace, and adjust ignition system components

2.10 Troubleshoot and isolate engine malfunctions

2.11 Explain the functions of the major subsections of a gas turbine engine

2.12 Identify major subsystem components of a diesel engine

2.13 Identify the major operational systems of an outboard engine

2.14 Identify community and technical resources

Application

CONTENT/CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

2.1 Identify the major subsystems of the automobile engine

COURSE

Energy and Power (8448)

2.1

PERFORMANCE OBJECTIVE

P2.1 Given access to an automobile engine, identify the major subsystems of the engine with 100% accuracy on an instructor-prepared worksheet.

SELECTED ENABLING OBJECTIVES

E2.1.1 Identify a four-, six-, and eight-cylinder engine and the unique features of each.

E2.1.2 List the components of an automobile engine.

E2.1.3 Categorize automobile engine components into major subsystems.

CRITERION-REFERENCED MEASURE

C2.1 Engine systems identified with 100% accuracy on an instructor-prepared worksheet.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Display three different engine blocks and have the students examine each (E2.1.1).

2. Use a disassembled engine to explain the major subsystems of the engine and the components of each (E2.1.2).

3. Develop a handout showing components of major engine subsystems; have students label the components as to their subsystem category (E2.1.3).

SELECTED TOOLS AND MATERIALS

Drive sockets, 3/8" and 1/2"
Screwdriver, Phillips head
Screwdriver, flat head
4-, 6-, and 8-cylinder engine blocks
Disassembled engine
Teacher-prepared worksheet on engine subsystems

SELECTED AUDIOVISUAL MATERIALS

Filmstrips/Cassettes: The Basic Engine. Prentice-Hall Media.

SELECTED REFERENCES

Automotive Encyclopedia. Revised ed., Toboldt and Johnson.
Power--Prime Mover of Technology. Duffy.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.2 Compare diesel and gasoline engine operating principles

COURSE

Energy and Power (8448)

2.2

PERFORMANCE OBJECTIVE

P2.2 Given access to several types of engines (examples: Wankel, Sterling, turbine, diesel, and gasoline), compare diesel and gasoline engine operating principles with 90% accuracy on a teacher-prepared test.

SELECTED ENABLING OBJECTIVES

E2.2.1 Explain the principles of operation for the Wankel engine.

E2.2.2 Cite the advantages and disadvantages of the Sterling engine.

E2.2.3 List the types of turbine engines in use today.

E2.2.4 Explain the differences in operating principles between diesel and gasoline engines.

CRITERION-REFERENCED MEASURE

C2.2 Teacher-prepared test on diesel and gasoline engines, 90% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students research and present reports on different types of engines (E2.2.1-E2.2.4).

2. Lead a class discussion on the differences and similarities among internal combustion engines (E2.2.1-E2.2.4).

SELECTED TOOLS AND MATERIALS

Drive sockets, 3/8" and 1/2"
Combination wrenches
Model of rotary engine
Model of Sterling engine
Model of diesel engine
Model of 4-cycle engine
Model of turbine engine
Teacher-prepared test

SELECTED AUDIOVISUAL MATERIALS

Filmstrip: ABC of the Diesel Engine, Revised ed. Instructional Media Technology, Virginia Department of Education. (#20510)

Filmstrips/Cassettes: Introduction to the Diesel Engine. Prentice-Hall Media.

SELECTED REFERENCES

Exploring Power Mechanics. 3rd ed. Glen.
Power--Prime Mover of Technology. Duffy.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.3 Explain the function of fuel system components

COURSE

Energy and Power (8448)

2.3

PERFORMANCE OBJECTIVE

P2.3 Given a list of components used in the fuel system, explain function of fuel system components with 90% accuracy according to teacher-prepared guidelines.

SELECTED ENABLING OBJECTIVES

E2.3.1 Explain the function and design of fuel tanks.

E2.3.2 Describe the function of fuel pumps.

E2.3.3 Explain the function and design of a carburetor.

E2.3.4 Label the parts of a basic diaphragm fuel pump.

E2.3.5 Label the parts of a carburetor.

CRITERION-REFERENCED MEASURE

C2.3 Fuel system component functions explained with 90% accuracy according to teacher-prepared guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Display the different types of fuel tanks and explain the rationale for their design (E2.3.1).

2. Lead a class discussion on the different types of fuel pumps and principles of operation for each (E2.3.2).

3. Display a cutaway model of a fuel pump, identify the parts, and explain their functions (E2.3.2, E2.3.4).

4. Display a cutaway model of a carburetor, identify the subsystems and parts, and explain their functions (E2.3.3, E2.3.5).

5. Disassemble a carburetor and have students identify the parts (E2.3.5).

SELECTED TOOLS AND MATERIALS

Screwdrivers, flat head
Open end wrenches
Carburetors
Cutaway model of fuel pump
Cutaway model of carburetor
Teacher-prepared guidelines on fuel system components
Teacher-prepared worksheet on fuel pumps
Teacher-prepared worksheet on carburetors

SELECTED AUDIOVISUAL MATERIALS

Filmstrip/Cassette: "The Fuel System," The Basic Engine. Prentice-Hall Media.

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.
Small Gasoline Engines Training Manual. 3rd ed. Pipe.

Application

CONTENT/CONCEPT

2. EXPLORING POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

2.4 Adjust and set ignition timing

COURSE

Energy and Power (8448)

2.4

PERFORMANCE OBJECTIVE

P2.4 Given access to an automobile ignition system and other necessary resources, adjust and set ignition timing in accordance with the manufacturer's specifications.

SELECTED ENABLING OBJECTIVES

E2.4.1 List ignition parts and describe the function of each component.

E2.4.2 Identify, using a drawing or illustration, the components in a basic ignition system.

E2.4.3 Describe how each individual component works in conjunction with its system.

E2.4.4 List the components of the primary and secondary systems of the ignition.

E2.4.5 Describe the difference between two-, four-, six-, and eight-cylinder ignition systems.

E2.4.6 Explain ignition timing and firing order.

CRITERION-REFERENCED MEASURE

C2.4 Ignition timing adjusted and set in accordance with the manufacturer's specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Point out the major components of an ignition system; have students describe the function of ignition system components and subsystems (E2.4.1-E2.4.4).

2. Demonstrate how to set ignition timing (E2.4.6).

3. Explain the purpose of firing order and the differences in ignition timing in two-, four-, six-, and eight-cylinder engines (E2.4.5, E2.4.6).

SELECTED TOOLS AND MATERIALS

Drive sockets, 3/8" and 1/2"
Screwdrivers, flat head
Combination wrenches
4-, 6-, and 8-cylinder blocks
Teacher-prepared worksheet on ignition systems
Manufacturer's tune-up manual

SELECTED AUDIOVISUAL MATERIALS

Filmstrip/Cassette: "Ignition Service," Small Engine Service and Overhaul. Prentice-Hall Media.

SELECTED REFERENCES

Auto Mechanics Fundamentals. Stockel.
Small Gasoline Engines Training Manual. 3rd ed. Pipe.

Application

CONTENT/CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

2.5 Maintain and service a cooling system

COURSE

Energy and Power (8448)

2.5

PERFORMANCE OBJECTIVE

P2.5 Given access to an automobile and other necessary resources and classroom instruction on cooling systems, maintain and service a cooling system in accordance with manufacturer's specifications.

SELECTED ENABLING OBJECTIVES

E2.5.1 Use a basic drawing of a cooling system to identify and label the parts of the system.

E2.5.2 Describe the function of the components of the cooling system.

E2.5.3 State how heat is transferred from engine parts to the liquid cooling system.

E2.5.4 Describe how air flow through the components and around the engine is accomplished.

E2.5.5 Explain how the engine maintains a constant temperature.

E2.5.6 Demonstrate how to fill out a maintenance and service chart for a cooling system.

CRITERION-REFERENCED MEASURE

C2.5 Cooling system maintained and serviced in accordance with the manufacturer's specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students identify and explain the function of a typical automobile cooling system's components (E2.5.1, E2.5.2).

2. Present information on the design of engines and the necessary heat dissipation (E2.5.3-E2.5.5).

3. Discuss the proper maintenance and servicing of cooling systems (E2.5.6).

SELECTED TOOLS AND MATERIALS

Drive sockets, 3/8" and 1/2"
Screwdrivers, flat head
Pliers
Antifreeze
Teacher-prepared worksheet on cooling system maintenance and service
Funnels
Manufacturer's service manual

SELECTED AUDIOVISUAL MATERIALS

Filmstrip/Cassette: "The Lubricating and Cooling Systems," The Basic Engine. Prentice-Hall Media.

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Power--Prime Mover of Technology. Duffy.

Application

CONTENT/CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

2.6 Identify the major components of a transmission

COURSE

Energy and Power (8448)

2.6

PERFORMANCE OBJECTIVE

P2.6 Given diagrams of manual and automatic transmissions, identify the major components of each transmission with 100% accuracy on an instructor-prepared worksheet.

SELECTED ENABLING OBJECTIVES

E2.6.1 Cite the two main types of transmissions and their major differences.

E2.6.2 Identify the basic components of manual and automatic transmissions.

E2.6.3 Use a schematic to trace the transfer of energy through a manual three-speed transmission.

E2.6.4 Use a schematic to trace the transfer of energy through an automatic transmission.

CRITERION-REFERENCED MEASURE

C2.6 Major components of manual and automatic transmission identified with 100% accuracy on instructor-prepared worksheet.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Demonstrate the operation of automatic and manual transmissions; point out their major differences (E2.6.1).

2. Have students, using disassembled automatic and manual transmissions, identify and explain the function of major transmission parts (E2.6.2).

3. Explain how energy is transferred in manual and automatic transmissions; have students discuss the differences between the two types (E2.6.3, E2.6.4).

SELECTED TOOLS AND MATERIALS

Disassembled manual transmission
Disassembled automatic transmission
Schematics/diagrams of manual and automatic transmissions
Instructor-prepared worksheet

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Auto Mechanics Fundamentals. Stockel.

Application

CONTENT/CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

2.7 Trace the transfer of energy through a power train

COURSE

Energy and Power (8448)

2.7

PERFORMANCE OBJECTIVE

P2.7 Given a diagram of a power train and the necessary classroom instruction, trace the transfer of energy through the power train with 100% accuracy on a teacher-prepared worksheet.

SELECTED ENABLING OBJECTIVES

E2.7.1 Identify the major components of a differential.

E2.7.2 Explain the function of the major components in a power train.

E2.7.3 Label a power train diagram with arrows to show the rotation of each part.

CRITERION-REFERENCED MEASURE

C2.7 Transfer of energy through the power train traced with 100% accuracy on teacher-prepared worksheet.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Display a disassembled differential; have students identify the major components and explain the function of each (E2.7.1, E2.7.2).

2. Lead a class discussion on the principles associated with the wheel and axle (E2.7.3).

3. Use a schematic/diagram to show the transfer of energy from the drive shaft to the axle (E2.7.3).

SELECTED TOOLS AND MATERIALS

Disassembled differential
Drive shaft
Drive sockets, 3/8" and 1/2"
Drift pin
Schematics/diagrams of a power train
Automotive power train
Teacher-prepared worksheet on power trains

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Automotive Encyclopedia. Revised ed., Toboldt and Johnson.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.8 Select oil by grade, weight, and additive

COURSE

Energy and Power (8448)

2.8

PERFORMANCE OBJECTIVE

P2.8 Given access to an automobile engine and descriptions of climatic conditions, select the proper oil by grade, weight, and additive in accordance with the manufacturer's specifications.

SELECTED ENABLING OBJECTIVES

E2.8.1 Identify the different grades, weights, and additives available for motor oil.

E2.8.2 Explain the function of the engine's oil system.

E2.8.3 Label the components of an engine oil system on a diagram or illustration.

E2.8.4 List three environmental conditions that impact the selection of oil grade and additives.

CRITERION-REFERENCED MEASURE

C2.8 Oil selected by grade, weight, and additive in accordance with manufacturer's specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Present information on the types of oil used in engines and explain the various weights, grades, and additives of oil available (E2.8.1).

2. Identify the major function of the engine oil system; have students discuss why this system is essential to engine operation (E2.8.2).

3. Have students list and explain the function of the engine and system components (E2.8.3).

4. Explain how environmental conditions determine oil grade selection and additive use (E2.8.4).

SELECTED TOOLS AND MATERIALS

Oil system components
Oil, various weights, grades, and additives
Diagram of an engine oil system
Disassembled engine
Funnels
Oil can spouts
Manufacturer's service manual

SELECTED AUDIOVISUAL MATERIALS

Filmstrip/Cassette: "The Lubricating and Cooling System," The Basic Engine. Prentice-Hall Media.

SELECTED REFERENCES

Auto Mechanics Fundamentals. Stockel.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.9 Remove, inspect, reinstall or replace, and adjust ignition system components

COURSE

Energy and Power (8448)

2.9

PERFORMANCE OBJECTIVE

P2.9 Given access to an automobile in need of an ignition system tune-up, remove, inspect, reinstall or replace, and adjust ignition system components according to manufacturer's specifications.

SELECTED ENABLING OBJECTIVES

E2.9.1 List the requirements of an ignition system tune-up.

E2.9.2 Outline procedures for the removal, inspection, repair, and adjustment of ignition system components.

E2.9.3 Describe how to reinstall or replace ignition system components.

E2.9.4 Cite the steps necessary to adjust ignition system components to meet manufacturer's specifications.

CRITERION-REFERENCED MEASURE

C2.9 Ignition system components removed, inspected, reinstalled or replaced, and adjusted according to manufacturer's specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Explain the function of the major components of an ignition system; cite the tune-up procedures for each component (E2.9.1).

2. Demonstrate techniques used to remove, inspect, and reinstall ignition system components; have students practice these techniques (E2.9.2, E2.9.3).

3. Demonstrate how to adjust an ignition system; have students practice adjustment procedures (E2.9.4).

SELECTED TOOLS AND MATERIALS

Disassembled engine
Screwdriver, flat head
Distributor wrenches
Spark plug socket
Drive sockets, 3/8" and 1/2"
Manufacturer's service manual
Timing light
Flat blade feeler gauges
Spark plug wire gauges

SELECTED AUDIOVISUAL MATERIALS

Filmstrip/Cassette: "Ignition Service," Small Engine Service and Overhaul. Prentice-Hall Media.

SELECTED REFERENCES

Auto Mechanics Fundamentals. Stockel.

Application

CONTENT/CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

2.10 Troubleshoot and isolate engine malfunctions

COURSE

Energy and Power (8448)

2.10

PERFORMANCE OBJECTIVE

P2.10 Given access to malfunctioning automobile engine, troubleshoot and isolate engine malfunctions in accordance with the manufacturer's specifications.

SELECTED ENABLING OBJECTIVES

E2.10.1 Use visual and general inspections to identify problems in the various automotive systems.

E2.10.2 Describe general procedures to isolate malfunctions in engine.

E2.10.3 Select proper charts and manuals to identify replacement part numbers for worn or damaged parts.

CRITERION-REFERENCED MEASURE

C2.10 Engine malfunctions isolated in accordance with manufacturer's specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Demonstrate procedures used to trace engine system malfunctions (E2.10.1, E2.10.2).
2. Explain procedures used to obtain parts numbers for replacement parts (E2.10.3).
3. Demonstrate the use of special tools used to isolate malfunctions (E2.10.1, E2.10.2).

SELECTED TOOLS AND MATERIALS

Vacuum gauges
Dwell indicator
Timing light
Pressure gauges
Tachometer
Disassembled engine
Multimeter
Manufacturer's shop manual

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Auto Mechanics Fundamentals. Stockel.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.11 Explain the functions of the major subsections of a gas turbine engine

COURSE

Energy and Power (8448)

2.11

PERFORMANCE OBJECTIVE

P2.11 Given a diagram of a turbine engine and classroom instruction, explain the functions of the major subsections of a gas turbine engine with 90% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E2.11.1 Cite the history and development of the gas turbine engine in aircraft, automobiles, trucks, trains, and marine equipment.

E2.11.2 Explain the basic principles of operation and heat expansion in turbine engines and Bernoulli's principles as applied to turbine engines.

E2.11.3 Identify the operational systems of the turbine's compressor section, combustion chamber, and power turbine on a model or drawing.

CRITERION-REFERENCED MEASURE

C2.11 Instructor-prepared quiz on gas turbine engines, 90% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Conduct a class discussion on the history and development of gas turbines (E2.11.1).
2. Present information on the basic principles of turbine engine operation; have students describe these principles in writing (E2.11.2).
3. Explain Bernoulli's theory of fluidal flow (E2.11.1).
4. Develop a worksheet and diagram for students to use in developing and explaining the function of the compressor section, combustion chambers, and power turbine (E2.11.3).

SELECTED TOOLS AND MATERIALS

Diagrams of turbine engine sections
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

Filmstrip: ABC of the Gas Turbine. Instructional Media Technology, Virginia Department of Education. (#20410)

SELECTED REFERENCES

Exploring Power Mechanics. 3rd ed. Glen.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL ENGINES (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.12 Identify major subsystem components of a diesel engine

COURSE

Energy and Power (8448)

2.12

PERFORMANCE OBJECTIVE

P2.12 Given classroom discussion and a diagram of a diesel engine, identify major subsystem components of a diesel engine with 90% accuracy on a teacher-prepared worksheet.

SELECTED ENABLING OBJECTIVES

E2.12.1 Identify the location of diesel engine subsystems.

E2.12.2 Compare the gasoline engine systems to those of a diesel engine.

E2.12.3 List the advantages and disadvantages of the diesel engine.

E2.12.4 Cite the general applications for diesel engines.

CRITERION-REFERENCED MEASURE

C2.12 Major subsystem components of a diesel engine identified with 90% accuracy on a teacher-prepared worksheet.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Display the component parts of a diesel engine; have students identify their location in the engine (E2.12.1).

2. Lead a class discussion on the similarities and differences between the diesel and gasoline engines (E2.12.2).

3. Conduct a brainstorming session to develop a list of the advantages and disadvantages of a diesel engine (E2.12.3).

4. Present information on the uses and applications of diesel engines (E2.12.4).

SELECTED TOOLS AND MATERIALS

Drive sockets, 3/8" and 1/2"
Box end wrenches
Model of diesel engine
Model of gasoline engine
Teacher-prepared worksheet on diesel engines

SELECTED AUDIOVISUAL MATERIALS

Filmstrip: ABC of the Diesel Engine. Revised ed. Instructional Media Technology, Virginia Department of Education. (#20510)

Filmstrips/Cassettes: Introduction to the Diesel Engine. Prentice-Hall Media.

SELECTED REFERENCES

Exploring Power Mechanics. 3rd ed. Glen.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.13 Identify the major operational systems of an outboard engine

COURSE

Energy and Power (8448)

2.13

PERFORMANCE OBJECTIVE

P2.13 Given classroom instruction and a diagram of an outboard engine, identify major operational systems of an outboard engine with 90% accuracy on a teacher-prepared worksheet.

SELECTED ENABLING OBJECTIVES

E2.13.1 Identify the location of the components of an outboard engine.

E2.13.2 Describe the operation of the outboard engine and the function of each component.

E2.13.3 Cite service procedures for outboard engines.

CRITERION-REFERENCED MEASURE

C2.13 Major operational systems of an outboard engine identified with 90% accuracy on a teacher-prepared worksheet.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Present information on the major parts of an outboard and their location in the engine (E2.13.1).

2. Have students explain the function of the engine's mechanical system, using sketches, charts, and drawings (E2.13.2).

3. Disassemble an outboard motor, demonstrate service procedures, and reassemble (E2.13.3.).

SELECTED TOOLS AND MATERIALS

Drive sockets, 3/8" and 1/2"
Impact driver
Screwdrivers, flat head
Manufacturer's service manual
Model of outboard engine
Diagrams of outboard engine
Teacher-prepared worksheet on outboard engines

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

Application

CONTENT / CONCEPT

2. EXPLORING THERMAL POWER (INTERNAL COMBUSTION ENGINES)

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

2.14 Identify community and technical resources

COURSE

Energy and Power (8448)

2.14

PERFORMANCE OBJECTIVE

P2.14 Given the necessary resources and supplies, identify community and technical resources that may be incorporated in student organization classroom activities. Identification must be rated acceptable according to organization guidelines.

SELECTED ENABLING OBJECTIVES

E2.14.1 Identify possible community and technical resources to investigate.

E2.14.2 List factors involved in successful planning for a field trip or guest speaker.

E2.14.3 Participate in committee or class activities to select a possible classroom speaker or to plan a class field trip.

CRITERION-REFERENCED MEASURE

C2.14 Identifications of community and technical resources rated acceptable according to student organization guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Assist students in identifying possible community and technical resources to investigate as a student organization project (E2.14.1).

2. Discuss factors involved in successful planning for a field trip or guest speaker (E2.14.2).

3. Have students invite speakers from industry to speak on topics of interest or to give special demonstrations; involve students in selecting and planning field trips (E2.14.3).

SELECTED TOOLS AND MATERIALS

Directories listing local industries

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Student Association Activities in Industrial Arts Instruction. Virginia Department of Education.

CONTENT/CONCEPT

3. EXPLORING PNEUMATICS

TASKS/COMPETENCIES

3.1 Construct a simple pneumatic circuit

3.2 Construct a complex pneumatic circuit

3.3 Construct a multifunction pneumatic circuit

Application

CONTENT / CONCEPT

3. EXPLORING PNEUMATICS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

3.1 Construct a simple pneumatic circuit

COURSE

Energy and Power (8448)

3.1

PERFORMANCE OBJECTIVE

P3.1 Given a schematic of a pneumatic circuit and other necessary tools and equipment, construct a simple pneumatic circuit. Circuit must be operational and must meet all criteria on instructor-prepared checklist.

SELECTED ENABLING OBJECTIVES

E3.1.1 Identify pneumatic components and their corresponding symbols.

E3.1.2 Outline the procedures for selecting components and constructing a simple circuit, using a schematic as a guide.

E3.1.3 Describe how to select the proper components and construct a simple circuit which uses directional control pressure.

CRITERION-REFERENCED MEASURE

C3.1 Simple pneumatic circuit constructed that is operational and meets all criteria on instructor-prepared checklist.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Provide information on basic pneumatic components; have students identify the symbol for each component (E3.1.1).

2. Demonstrate how to construct a pneumatic circuit, using a schematic diagram as a guide (E3.1.2).

3. Demonstrate how to construct a pneumatic circuit that uses directional control pressure (E3.1.3).

SELECTED TOOLS AND MATERIALS

Pneumatic system components
Air compressor
Pneumatic connecting lines
Pneumatic trainer
Instructor-prepared checklist

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

Application

CONTENT/CONCEPT

3. EXPLORING PNEUMATICS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

3.2 Construct a simple pneumatic circuit

COURSE

Energy and Power (8448)

3.2

PERFORMANCE OBJECTIVE

P3.2 Given the necessary tools and pneumatic circuit components, construct a complex pneumatic circuit that is a cylinder extension, delay, or automatic circuit. Circuit must be operational and must meet all criteria on instructor-prepared checklist.

SELECTED ENABLING OBJECTIVES

E3.2.1 List the characteristics of a cylinder extension circuit, a delay circuit, and an automatic circuit.

E3.2.2 Identify, using schematic diagrams, the components of cylinder extension, delay, and automatic circuits.

E3.2.3 Explain how to select the proper components and construct cylinder extension, delay (timing), and automatic circuits.

E3.2.4 List the applications of cylinder extension, delay, and automatic circuits in industry.

CRITERION-REFERENCED MEASURE

C3.2 Complex pneumatic circuit constructed that is a cylinder extension, delay, or automatic circuit, is operational, and meets all criteria on instructor-prepared checklist.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Lead a class discussion on the types of complex pneumatic circuits (E3.2.1).

2. Describe the components and demonstrate the construction and operation of a cyclinder extension circuit, a delay circuit, and an automatic circuit (E3.2.2, E3.2.3).

3. Have students report on the applications of each complex pneumatic circuit and the unique components and characteristics of each (E3.2.4).

SELECTED TOOLS AND MATERIALS

Pneumatic system components
Pneumatic trainer
Teacher-prepared worksheet on pneumatic symbols
Instructor-prepared checklist

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

Application

CONTENT/CONCEPT

3. EXPLORING PNEUMATICS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

3.3 Construct a multifunction pneumatic circuit

COURSE

Energy and Power (8448)

3.3

PERFORMANCE OBJECTIVE

P3.3 Given the necessary classroom instruction and the proper components and tools, construct a multifunction pneumatic circuit. Circuit must be able to shut itself off and must meet all criteria on instructor-prepared checklist.

SELECTED ENABLING OBJECTIVES

E3.3.1 Identify the components for construction of a circuit that uses two cylinders at the same time.

E3.3.2 List the steps in construction of a circuit where the extension of each cylinder is controlled individually.

E3.3.3 Explain how to construct a circuit where the extension of one cylinder will activate the extension of another cylinder to shut off the circuit.

CRITERION-REFERENCED MEASURE

C3.3 Multifunction pneumatic circuit constructed that is able to shut itself off and that meets all criteria on instructor-prepared checklist.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Explain the operation of pneumatic control devices used to operate two pneumatic circuits simultaneously (E3.3.1).

2. Demonstrate how to construct multifunction circuits that have cylinders controlled together or individually (E3.3.1, E3.3.2).

3. Construct and demonstrate the operation of a pneumatic multifunction circuit that will shut itself off (E3.3.3).

SELECTED TOOLS AND MATERIALS

Air compressor
Pneumatic system components
Pneumatic trainer
Instructor-prepared checklist

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Power--Prime Mover of Technology. Duffy.

CONTENT/CONCEPT

4. EXPLORING HYDRAULICS

TASKS/COMPETENCIES

4.1 Construct a controlled hydraulic circuit

4.2 Construct a hydraulic delay circuit

4.3 Construct a multifunction hydraulic circuit

Application

CONTENT/CONCEPT

4. EXPLORING HYDRAULICS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

4.1 Construct a controlled hydraulic circuit

COURSE

Energy and Power (8448)

4.1

PERFORMANCE OBJECTIVE

P4.1 Given the proper components, equipment, and tools, construct a controlled hydraulic circuit. Circuit must have a regulated flow rate and must be rated acceptable according to instructor-prepared guidelines.

SELECTED ENABLING OBJECTIVES

E4.1.1 Outline the steps necessary to select the proper components and assemble a hydraulic circuit.

E4.1.2 Explain how to regulate hydraulic pressure, measure flow rate and rate of movement of cylinder, and record the measurements.

E4.1.3 Describe how to regulate the RPMs of a hydraulic motor.

CRITERION-REFERENCED MEASURE

C4.1 Controlled hydraulic circuit constructed so that it has a regulated flow rate and is rated acceptable according to instructor-prepared guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list the basic parts of a hydraulic circuit (example: directional control valve, flow meter, etc.) (E4.1.1, E4.1.2).

2. Construct and demonstrate the use of a circuit that will regulate hydraulic pressure, using a flow meter and a cylinder (E4.1.1, E4.1.2).

3. Demonstrate the operation of a hydraulic circuit that will regulate the movement of an extended cylinder (E4.1.1, E4.1.2).

4. Have students demonstrate the operation of a hydraulic circuit that will regulate the RPMs of a hydraulic motor (E4.1.3).

SELECTED TOOLS AND MATERIALS

Hydraulic system components
Hydraulic trainer
Instructor-prepared guidelines

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Exploring Power Mechanics. 3rd ed. Glen.
Power--Prime Mover of Technology. Duffy.

Application

CONTENT / CONCEPT

4. EXPLORING HYDRAULICS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

4.2 Construct a hydraulic delay circuit

COURSE

Energy and Power (8448)

4.2

PERFORMANCE OBJECTIVE

P4.2 Given the proper components, equipment, and tools, construct a hydraulic delay circuit. Circuit must be able to activate another circuit and must be rated acceptable according to instructor-prepared guidelines.

SELECTED ENABLING OBJECTIVES

E4.2.1 Identify the steps required to construct a delay system hydraulic circuit.

E4.2.2 Explain how to construct a hydraulic delay system that fully extends a cylinder to activate another circuit mechanically.

E4.2.3 Describe the method used to construct a hydraulic circuit that has a delay system activated by the accumulated pressure within a relief valve.

CRITERION-REFERENCED MEASURE

C4.2 Hydraulic delay circuit constructed that is able to activate another circuit and that is rated acceptable according to instructor-prepared guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list the parts needed to construct a delayed hydraulic circuit (E4.2.1).

2. Demonstrate the process and parts needed to extend one cylinder and then to have this extended cylinder activate another circuit (E4.2.2).

3. Show the students how to convert a circuit that has a delay system activated by pressure built up in a relief valve (E4.2.3).

SELECTED TOOLS AND MATERIALS

Hydraulic system components
Hydraulic trainer
Instructor-prepared guidelines

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Exploring Power Mechanics. 3rd ed. Glen.

Application

CONTENT/CONCEPT

4. EXPLORING HYDRAULICS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

4.3 Construct a multifunction hydraulic system

COURSE

Energy and Power (8448)

4.3

PERFORMANCE OBJECTIVE

P4.3 Given the proper components, equipment, and tools, construct a multifunction hydraulic system. System must use two cylinders actuating opposite of each other and must meet all criteria on instructor-prepared checklist.

SELECTED ENABLING OBJECTIVES

E4.3.1 List steps needed to construct a hydraulic circuit that uses two cylinders activated at the same time.

E4.3.2 Explain how to construct a hydraulic circuit, using two cylinders and controlling the retraction of both so that one is twice as fast as the other.

CRITERION-REFERENCED MEASURE

C4.3 Multifunction hydraulic system constructed so that it uses two cylinders actuating opposite of each other and meets all criteria on instructor-prepared checklist.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Show students how fluid flows through the lines of a circuit that operates two cylinders at the same time (E4.3.1).

2. Show students how the fluid flows through a circuit which uses two cylinders that move at different speeds (E4.3.2).

SELECTED TOOLS AND MATERIALS

Hydraulic system components
Hydraulic trainer

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Exploring Power Mechanics. 3rd ed. Glen.

CONTENT/CONCEPT

5. EXPLORING ELECTRIC MOTORS

TASKS/COMPETENCIES

5.1 Identify sizes and types of electric motors

5.2 Determine the working characteristics of a motor

5.3 Explain how a split-phase motor operates

5.4 Identify characteristics of the permanent split-capacitor motor

5.5 Construct a circuit containing a shaded pole motor

5.6 Identify the capacitor start/run motor by its physical characteristics

5.7 Explain the principles of operation of a series motor

5.8 Construct a circuit, using a three-phase motor

5.9 Explain electrical energy transfer through mutual induction in transformers

5.10 Participate in school or community improvement activities

Application

CONTENT/CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

5.1 Identify sizes and types of electric motors

COURSE

Energy and Power (8448)

5.1

PERFORMANCE OBJECTIVE

P5.1 Given a list of specific tasks requiring an electric motor, identify the correct size and type of electric motor for each task with 100% accuracy on instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E5.1.1 List the various types of motor mounts and enclosures for safe motor operation.

E5.1.2 Explain the duty cycle of motors.

E5.1.3 Identify specific components which allow for lubrication and cooling.

E5.1.4 Identify motor sizes and explain their relationship to motor uses.

CRITERION-REFERENCED MEASURE

C5.1 Sizes and types of electric motors identified for specific tasks with 100% accuracy on instructor-prepared quiz.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Describe different types of motor mounts and their enclosures (examples: rigid base, fixed frame, rigid base with adjusting screws) (E5.1.1).

2. Define continuous duty motors and intermittent duty motors; have students identify when to to use each type (E5.1.2).

3. Have students develop a list of the parts of a motor's cooling and lubrication systems and discuss their importance to motor operation (E5.1.3).

4. List several different sizes of electric motors, including shaded pole induction, split-phase, permanent split-capacitor induction, and soft-start (E5.1.4).

SELECTED TOOLS AND MATERIALS

Electric motors, various sizes and types
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

AV Kit: Electric Motors. AAVIM.
Transparency Masters: Electric Motors: Selection, Protection, Drives. AAVIM.

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Electric Motors: Selection, Protection, Drives. AAVIM.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

5.2 List the working characteristics of a motor

COURSE

Energy and Power (8448)

5.2

PERFORMANCE OBJECTIVE

P5.2 Given access to an electric motor and the necessary classroom instruction, list the working characteristics of the motor with 100% accuracy according to the manufacturer's data plate.

SELECTED ENABLING OBJECTIVES

E5.2.1 List the information which may be obtained from a motor name plate.

E5.2.2 Record information obtained from a motor name plate.

E5.2.3 Use motor catalogs to find replacement motors and motor parts.

E5.2.4 Calculate cost factor in operating specific motors.

CRITERION-REFERENCED MEASURE

C5.2 Working characteristics of a motor identified with 100% accuracy according to the manufacturer's data plate.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Show students the location of a motor's name plate; define all the information (examples: model, type, serial number, horsepower, volts, RPM, duty rating, and amps) (E5.2.1).

2. Have students record motor information on a chart (E5.2.2).

3. Explain how to use a catalog to find different styles and types of motors (E5.2.3).

4. Demonstrate how to compute the cost of operating a three-phase general purpose motor for 30 hours; provide sample problems for students to practice making these computations (E5.2.4).

SELECTED TOOLS AND MATERIALS

Shaded pole motor
Capacitor-induction motor
Motor with capacitor on side
Motor with capacitor on top
Split-phase motor
Soft-start motor
Permanent-split motor

SELECTED AUDIOVISUAL MATERIALS

AV Kit: Electric Motors. AAVIM.
Transparency Masters: Electric Motors: Selection, Protection, Drives. AAVIM.

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

5.3 Explain how a split-phase motor operates

COURSE

Energy and Power (8448)

5.3

PERFORMANCE OBJECTIVE

P5.3 Given classroom discussion and access to a circuit with a split-phase motor, explain how a split-phase motor operates with 100% accuracy on an intructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E5.3.1 Identify components in a split-phase motor and explain the function of each component.

E5.3.2 Explain how split-phase motors start and run.

E5.3.3 State the uses and advantages of split-phase motors.

E5.3.4 Explain the theory of split-phase motor operation.

E5.3.5 Explain the lag and leading principle of current and voltage in inductive circuits.

E5.3.6 Describe how to assemble and operate a circuit with a split-phase motor.

CRITERION-REFERENCED MEASURE

C5.3 Instructor-prepared quiz on split-phase motors, 100% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list the parts of a split-phase motor and define their functions (E5.3.1, E5.3.2).
2. Conduct a class discussion on the advantages and uses of a three-phase motor and a split-phase motor (E5.3.2, E5.3.3).
3. Demonstrate how a split-phase motor operates (E5.3.4, E5.3.5).
4. Construct a circuit with a split-phase motor (E5.3.6).

SELECTED TOOLS AND MATERIALS

Split-phase motor
Screwdrivers, flat head
Nut driver
Instructor-prepared quiz
Soldering iron

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
How Electric Motors Start and Run. AAVIM.

Application

CONTENT / CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

5.4 Identify chacteristics of the permanent split-capacitor motor

COURSE

Energy and Power (8448)

5.4

PERFORMANCE OBJECTIVE

P5.4 Given classroom discussion and access to a permanent split-capacitor motor, identify characteristics of the permanent split-capacitor motor with 95% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E5.4.1 Identify and explain the function of each component in a split-capacitor motor.

E5.4.2 Describe how permanent split-capacitor motors start and run.

E5.4.3 Explain the sizing and measuring of capacitors.

E5.4.4 Cite the uses and advantages of a split-capacitor motor.

E5.4.5 Describe how to assemble and operate a circuit with a split-capacitor motor.

CRITERION-REFERENCED MEASURE

C5.4 Instructor-prepared quiz on permanent split-capacitor motors, 95% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Point out, using a model or diagram, the parts of a permanent split-capacitor motor (E5.4.1).

2. Describe the function of each part in a permanent split-capacitor motor; lead a class discussion on their start and run principles (E5.4.1, E5.4.2).

3. Explain the use of capacitor motors for hard starting loads (E5.4.3).

4. Conduct a brainstorming session for students to develop a list of advantages and uses of a split-capacitor motor (E5.4.4).

5. Design, construct, and demonstrate use of a circuit that includes a split-capacitor motor (E5.4.5).

SELECTED TOOLS AND MATERIALS

Split-capacitor motor
Copper wire
Nut driver
Screwdriver, flat head
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
How Electric Motors Start and Run. AAVIM.

Application

CONTENT/CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

5.5 Construct a circuit containing a shaded pole motor

COURSE

Energy and Power (8448)

5.5

PERFORMANCE OBJECTIVE

P5.5 Given classroom instruction, access to a shaded pole motor, and other necessary tools and equipment, construct a circuit containing a shaded pole motor. Circuit must be functional and must meet all criteria on instructor-prepared checklist.

SELECTED ENABLING OBJECTIVES

E5.5.1 Identify the components in a shaded pole motor.

E5.5.2 State the function of each component.

E5.5.3 Explain how shaded pole motors start and run.

E5.5.4 List some practical uses of shaded pole motors.

E5.5.5 Describe how to assemble and operate a circuit with a shaded pole motor.

E5.5.6 Outline procedures for taking voltage measurements of circuit with shaded pole motor.

CRITERION-REFERENCED MEASURE

C5.5 Circuit containing a shaded pole motor constructed so that it is functional and meets all criteria on instructor-prepared checklist.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Lead a class discussion on the identification and operating principles of each part of a shaded pole motor (E5.5.2).
2. Use a demonstration model to show students how shaded pole motors start and run (E5.5.3).
3. Have students look around the school and make a list of different types of equipment that use a shaded pole motor (E5.5.4).
4. Have students construct and operate a circuit with a shaded pole motor (E5.5.1-E5.5.5).
5. Have students take voltage measurements of constructed circuits (E5.5.6).

SELECTED TOOLS AND MATERIALS

Shaded pole motor
Copper wire
Nut driver
Model of motor
Instructor-prepared checklist

SELECTED AUDIOVISUAL MATERIALS

Film: Electrical Safety--Living With a Strong, Silent Partner. Audiovisual Services, Virginia Department of Education. (#73110).

Film: Electricity--Handle With Care. Audiovisual Services, Virginia Department of Education. (#36708).

Film: Safety With Electricity. Audiovisual Services, Virginia Department of Education. (#67905).

SELECTED REFERENCES

Electricity Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Motors Start and Run. AAVIM.

Application

CONTENT/CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

5.6 . Identify the capacitor start/run motor by its physical characteristics

COURSE

Energy and Power (8448)

5.6

PERFORMANCE OBJECTIVE

P5.6 Given access to five electrical motors, identify the capacitor start/run motor by its physical characteristics with 100% accuracy on a teacher-prepared quiz.

SELECTED ENABLING OBJECTIVES

E5.6.1 Identify components of a capacitor start/run motor.

E5.6.2 Cite the function of each component of the capacitor start/run motor.

E5.6.3 Explain how capacitor start/run motors operate.

E5.6.4 List the practical uses and advantages of a capacitor start/run motor.

E5.6.5 Outline how to assemble and operate a circuit with a capacitor start/run motor.

E5.6.6 Explain the characteristics and operating principles of a capacitor start/run motor.

CRITERION-REFERENCED MEASURE

C5.6 Instructor-prepared quiz on capacitor start/run motor, 100% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list the parts of a capacitor start/run motor and describe function of each part (E5.6.1, E5.6.2).

2. Use a demonstration model to show students how the motor starts and runs (E5.6.3).

3. Lead a class discussion on the operating princples and uses of a capacitor start/run motor (E5.6.4, E5.6.6).

4. Construct and operate a circuit with a capacitor start/run motor; have students practice construction and operation processes (E5.6.5).

SELECTED TOOLS AND MATERIALS

Capacitor start/run motor
Copper wire
Screwdriver, flat head
Nut driver
Teacher-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

AV Kit: How Electric Motors Start and Run. AAVIM.

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
How Electric Motors Start and Run. AAVIM.

Application

CONTENT / CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

5.7 Explain the principles of operation of a series motor

COURSE

Energy and Power (8448)

5.7

PERFORMANCE OBJECTIVE

P5.7 Given classroom instruction, access to an electrical device containing a series motor, and other equipment and tools, explain the principles of operation of a series motor with 90% accuracy according to instructor-prepared guidelines.

SELECTED ENABLING OBJECTIVES

E5.7.1 Identify and explain the function of each component of the series motor.

E5.7.2 State how a series motor starts and runs.

E5.7.3 List the practical uses and advantages of a series motor.

E5.7.4 Describe how to assemble and operate a circuit with a series motor.

CRITERION-REFERENCED MEASURE

C5.7 Principles of operation of a series motor explained with 90% accuracy according to instructor-prepared guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list and describe the parts of a series motor (E5.7.1).
2. Demonstrate the operation of a series motor (E5.7.2).
3. Conduct a class discussion on the uses and advantages of a series motor (E5.7.3).
4. Demonstrate how to assemble and operate a series motor circuit; have students practice the procedures (E5.7.4).

SELECTED TOOLS AND MATERIALS

Series motor
Copper wire
Instructor-prepared guidelines

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.

Application

CONTENT / CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

5.8 Construct a circuit, using a three-phase motor

COURSE

Energy and Power (8448)

5.8

PERFORMANCE OBJECTIVE

P5.8 Given classroom instruction, access to a three-phase motor, and the necessary equipment and wiring diagrams, construct a circuit, using a three-phase motor. Circuit must be functional and must meet instructor-developed specifications.

SELECTED ENABLING OBJECTIVES

E5.8.1 Identify and explain the function of each component in a three-phase motor.

E5.8.2 Explain how three-phase motors start and run.

E5.8.3 Cite the uses and advantages of three-phase motors in industry, noting particularly the use of three-phase motors in laboratory equipment.

CRITERION-REFERENCED MEASURE

C5.8 Circuit with a three-phase motor constructed so that it is functional and meets instructor-developed specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list the parts of a three-phase motor and define the function of each part (E5.8.1).

2. Explain the operating principles of a three-phase motor; explain what applications industry has found for a three-phase motor (E5.8.2, E5.8.3).

SELECTED TOOLS AND MATERIALS

Three-phase motor
Wiring diagram
Copper wire
Instructor-developed specifications

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

5. EXPLORING ELECTRIC MOTORS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

5.9 Explain electrical energy tranfer through mutual induction in transformers

COURSE

Energy and Power (8448)

5.9

PERFORMANCE OBJECTIVE

P5.9 Given classroom instruction and diagrams of three types of transformers, explain electrical energy transfer through mutual induction in the transformers with 90% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E5.9.1 Identify the components and explain the functions of a transformer.

E5.9.2 Describe how to complete a circuit, using a simple power transformer.

E5.9.3 List steps in testing a transformer for shorts, continuity, and turns ratio.

CRITERION-REFERENCED MEASURE

C5.9 Instructor-prepared quiz on electrical energy transfer through mutual induction in transformers, 90% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Point out the components of a transformer; have students identify the function of each component (E5.9.1).

2. Present information on the theory behind a transformer's operation (examples: step-up voltage, step-down voltage) (E5.9.2).

3. Have each student wire a circuit, using an on-off switch, a bell, and a transformer (E5.9.2).

4. Demonstrate and then have each student examine and test a transformer (E5.9.3).

SELECTED TOOLS AND MATERIALS

Transformer
Bell
On-off switch
Continuity tester
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT/CONCEPT
5. EXPLORING ELECTRIC MOTORS

PROGRAM
INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY
5.10 Participate in school or community improvement activities

COURSE
Energy and Power (8448)

5.10

PERFORMANCE OBJECTIVE

P5.10 Given the necessary resources and supplies, participate in community or school improvement activities within the classroom setting. Participation must be rated acceptable according to student organization guidelines.

SELECTED ENABLING OBJECTIVES

E5.10.1 Identify possible school or community improvement projects.

E5.10.2 List factors to consider when planning and carrying out successful group projects.

E5.10.3 Select a community or school improvement project, determine tasks to be done, and determine duties and responsibilities of class members.

E5.10.4 Evaluate success of project upon completion.

CRITERION-REFERENCED MEASURE

C5.10 In-class participation in school or community improvement activities rated acceptable according to student organization guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Help students identify possible school or community improvement projects (E5.10.1).

2. Discuss factors to consider when planning and carrying out successful group projects (E5.10.2).

3 Help students select, plan, implement, and evaluate a school or community improvement project (E5.10.3, E5.10.4).

SELECTED TOOLS AND MATERIALS

Directories of local service and social agencies in community

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Annual Program of AIASA Activities, Guide 5. Virginia Department of Education.
Student Association Activities in Industrial Arts Instruction. Virginia Department of Education.

CONTENT/CONCEPT

6. EXPLORING MOTOR CONTROLS

TASKS/COMPETENCIES

6.1 Identify the controls used to start, stop, and reverse an electrical motor

6.2 Construct a motor speed control circuit

6.3 List the methods to control a motor by time or temperature

6.4 Construct a motor control, using a step-down transformer

6.5 Inspect, repair, and test an electrical motor

6.6 Participate in a group enterprise project

6.7 Participate in competitive events

Application

CONTENT / CONCEPT

6. EXPLORING MOTOR CONTROLS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

6.1 Identify the controls used to start, stop, and reverse an electrical motor

COURSE

Energy and Power (8448)

6.1

PERFORMANCE OBJECTIVE

P6.1 Given classroom instruction and access to a series motor, identify the controls used to start, stop, and reverse an electrical motor with 100% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E6.1.1 List the motor controls and the types of motors that have a reverse gear.

E6.1.2 Explain how to construct motor stop and start circuits, using manual starters, magnetic starters, and electronic starters.

E6.1.3 Trace flow of electricity from the controls to the motor.

E6.1.4 Select the proper relays to use with identified motor controls.

CRITERION-REFERENCED MEASURE

C6.1 Instructor-prepared quiz on motor controls, 100% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Have students list and discuss the various types of motor controls (examples: start, stop, reverse) (E6.1.1).

2. Describe the types of motors that can be reversed (E6.1.1).

3. Demonstrate operation of a circuit; point out reverse, start, and stop controls; trace flow of electricity through the system (E6.1.1-E6.1.3).

4. Display relays used for motor control; have students match relays with motor controls (E6.1.4).

SELECTED TOOLS AND MATERIALS

Model of motor
Motor controls (start, stop, reverse)
Relays
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

AV Kit: Electric Motors. AAVIM.
Transparency Masters: Electric Motors: Selection, Protection, Drives. AAVIM.

SELECTED REFERENCES

Electrical Power: Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

6. EXPLORING MOTOR CONTROLS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

6.2 Construct a motor speed control circuit

COURSE

Energy and Power (8448)

6.2

PERFORMANCE OBJECTIVE

P6.2 Given classroom instruction, the necessary resources, and equipment, construct a motor speed control circuit. Circuit must control the motor speed between 0-1500 RPMs and must be rated acceptable according to instructor-prepared guidelines.

SELECTED ENABLING OBJECTIVES

E6.2.1 List the various electrical devices that control motor speed.

E6.2.2 List three applications of electric motors that require motor speed control.

E6.2.3 Outline the steps in constructing a motor speed control circuit.

E6.2.4 Trace the flow of current through a motor speed control circuit.

CRITERION-REFERENCED MEASURE

C6.2 Motor speed control circuit constructed that controls the speed between 0-1500 RPMs and is rated acceptable according to instructor-prepared guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Display electrical devices that are used to control motor speed; have students identify motors that require such a device (E6.2.1, E6.2.2).

2. Demonstrate how to construct a motor speed control circuit, using a variable resistor; explain the principles of operation (E6.2.3, E6.2.4).

SELECTED TOOLS AND MATERIALS

Speed-controlled motor
Tachometer
On-off switch
Speed control devices (variable resistors, pulley stacks, electric brakes)
Instructor-prepared guidelines

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

6. EXPLORING MOTOR CONTROLS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

6.3 List the methods to control a motor by time or temperature

COURSE

Energy and Power (8448)

6.3

PERFORMANCE OBJECTIVE

P6.3 Given classroom instruction and examples of motor applications, list the methods to control a motor by time or temperature with 95% accuracy on an instructor-prepared quiz.

SELECTED ENABLING OBJECTIVES

E6.3.1 Identify electromechanical devices used as on-off motor controls.

E6.3.2 Explain how to wire a motor to start and stop, using a thermostat control.

E6.3.3 List the steps needed to wire a motor to start and stop, using a timed control.

CRITERION-REFERENCED MEASURE

C6.3 Instructor-prepared quiz on time and temperature motor controls, 95% accuracy.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Explain why certain motor applications require timed or temperature on-off controls (E6.3.1).

2. Have students list devices used to control motor starting and stopping time or temperature (E6.3.1).

3. Construct and demonstrate motor on-off circuits, using a timing device or a thermostat switch (E6.3.2, E6.3.3).

SELECTED TOOLS AND MATERIALS

Model of motor
Control for timed on-off
Control for temperature on-off
Instructor-prepared quiz

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

6. EXPLORING MOTOR CONTROLS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

6.4 Construct a motor control, using a step-down transformer

COURSE

Energy and Power (8448)

6.4

PERFORMANCE OBJECTIVE

P6.4 Given classroom instruction and the necessary equipment and tools, construct a motor control, using a step-down transformer. Motor control must function properly and must meet all criteria on instructor-prepared checklist.

SELECTED ENABLING OBJECTIVES

E6.4.1 Identify the input and output voltage terminals of a step-down transformer.

E6.4.2 Describe how to measure coil continuity of the transformer with a volt-ohmmeter.

E6.4.3 List three applications for using a step-down transformer to control a motor.

CRITERION-REFERENCED MEASURE

C6.4 Motor control constructed that uses a step-down transformer and that meets all criteria on instructor-prepared checklist.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Display a step-down transformer and explain its connections (E6.4.1).
2. Demonstrate transformer operation by applying several different voltages and measure the input and output voltages (E6.4.2).
3. Lead a class discussion on the applications of a step-down transformer as a motor control (E6.4.3).

SELECTED TOOLS AND MATERIALS

Step-down transformer
Electric motor
Volt-ohmmeter
Solderless connectors
Copper wire
Instructor-prepared checklist

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT/CONCEPT

6. EXPLORING MOTOR CONTROLS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK/COMPETENCY

6.5 Inspect, repair, and test an electrical motor

COURSE

Energy and Power (8448)

6.5

PERFORMANCE OBJECTIVE

P6.5 Given access to an inoperative electric motor and classroom instruction, inspect, repair, and test an electrical motor in accordance with the manufacturer's specifications.

SELECTED ENABLING OBJECTIVES

E6.5.1 Label the major components of a motor on a motor diagram worksheet.

E6.5.2 Select the proper lubricants to use for electric motors.

E6.5.3 Explain how to disassemble, inspect, and reassemble a centrifugal switch.

E6.5.4 List the steps in a routine inspection of a motor, including checking the brushes, armature, and lubrication systems.

CRITERION-REFERENCED MEASURE

C6.5 Electrical motor inspected, repaired, and tested in accordance with manufacturer's specifications.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Identify the parts of a motor that may require periodic maintenance; have students explain the importance of maintaining motor parts properly (E6.5.1).

2. Discuss and demonstrate the different methods used to lubricate motors (E6.5.2).

3. Discuss the purpose and demonstrate the operation of a centrifugal switch; point out the components that may wear out and require replacement (E6.5.3).

4. Display a disassembled motor; demonstrate the techniques used to inspect, repair, lubricate, and assemble the motor (E6.5.4).

SELECTED TOOLS AND MATERIALS

Electric motor
Nut driver
Screwdriver, flat head
Manufacturer's service manual
Lubricants
Centrifugal switches
Emery cloth
Contact cleaner
Motor diagram worksheet

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Electrical Power: Motors, Controls, Generators, Transformers. Kaiser.
Electricity and Electronics. Gerrish and Dugger.
Industrial Electricity. Miller.

Application

CONTENT / CONCEPT

6. EXPLORING MOTOR CONTROLS

PROGRAM

INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY

6.6 Participate in a group enterprise project

COURSE

Energy and Power (8448)

6.6

PERFORMANCE OBJECTIVE

P6.6 Given the necessary resources, tools, equipment, and supplies, participate in a group enterprise project planned as a classroom activity. Participation must be rated acceptable according to student organization guidelines.

SELECTED ENABLING OBJECTIVES

E6.6.1 Identify possible enterprise projects suitable for a classroom student organization.

E6.6.2 List factors to consider when planning and implementing a group enterprise project.

E6.6.3 Select a group enterprise project, determine tasks to be done, and determine duties of class members.

E6.6.4 Evaluate success of project upon completion.

CRITERION-REFERENCED MEASURE

C6.6 In-class participation rated acceptable according to student organization guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Help students identify possible enterprise projects; share previous project experiences (E6.6.1).

2. Discuss factors to consider when planning and implementing a group enterprise project; include servicing electric motors or engines and rebuilding or recycling mechanical systems for scrap materials (E6.6.1, E6.6.2).

3. Help students plan, organize, implement, and evaluate an enterprise project (E6.6.3, E6.6.4).

SELECTED TOOLS AND MATERIALS

None identified

SELECTED AUDIOVISUAL MATERIALS

Slides of previous contests or competitions, if available

SELECTED REFERENCES

Annual Program of AIASA Activities, Guide 5. Virginia Department of Education.
Student Association Activities in Industrial Arts Instruction. Virginia Department of Education.

Application

CONTENT / CONCEPT
6. EXPLORING MOTOR CONTROLS

PROGRAM
INDUSTRIAL ARTS (21.0105)

TASK / COMPETENCY
6.7 Participate in competitive events

COURSE
Energy and Power (8448)

6.7

PERFORMANCE OBJECTIVE

P6.7 Given the necessary resources, tools, equipment, and materials, participate in competitive events at the local, state, or national level. In-class participation must be rated acceptable according to school policy and student organization guidelines.

SELECTED ENABLING OBJECTIVES

E6.7.1 List types and purposes of competitive events; identify standards of achievement in craft quality, performance, and safety.

E6.7.2 Examine or establish procedures and rules for a competitive event; identify skills or qualifications needed to enter the event.

E6.7.3 Determine how achievements will be recognized or rewarded after the competition.

E6.7.4 Enter or conduct a competitive event.

CRITERION-REFERENCED MEASURE

C6.7 In-class participation rated acceptable according to school policy and student organization guidelines.

SELECTED INSTRUCTIONAL ACTIVITIES

1. Discuss types and purposes of competitive events (E6.7.1).
2. Display sample contest entry forms and rules; discuss competition procedures and skills or qualifications needed to enter designated competitions (E6.7.2).
3. Discuss ways achievement is rewarded or recognized in competitive events (E6.7.3).
4. Help students enter or conduct a competitive event (examples: Energy Conservation Contest, Resource Conservation Contest, Metric 500 Contest, and Research Paper Contest) (E6.7.4).

SELECTED TOOLS AND MATERIALS

None identified

SELECTED AUDIOVISUAL MATERIALS

None identified

SELECTED REFERENCES

Standards for AIASA Events, Guide 6. Virginia Department of Education.
Student Association Activities in Industrial Arts Instruction. Virginia Department of Education.

APPENDIX A

Information and Resources

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APPENDIX B

Audiovisual Materials

I. American Association for Vocational Instructional Materials
120 Driftmier Engineering Center
Athens, Georgia 30602

A. Electric Motors
B. Electric Motors: Selection, Protection, Drives
C. How Electric Motors Start and Run
D. Small Engines, Vol. 1
E. Small Engines, Vol. 2

II. Career Aids, Inc.
8950 Lurline Avenue, Department K634
Chatsworth, California 91311

Basic Electrical Circuits

III. Industrial Arts Education Service
Virginia Department of Education
P.O. Box 6Q
Richmond, Virginia 23216

A. Move With Tomorrow
B. Organizing the Industrial Arts Student Association

IV. Instructional Media Technology
Virginia Department of Education
P.O. Box 6Q
Richmond, Virginia 23216

A. ABC of the Diesel Engine, Revised ed. (#20510)
B. ABC of the Gas Turbine (#20410)
C. Engines--How They Work (#14805)
D. How to Conduct a Meeting (#04606)

V. Prentice-Hall Media
150 White Plains Road
Tarrytown, New York 10591

A. The Basic Engine
1. "The Four-Stroke-Cycle Internal Combustion Engine"
2. "Engine Components"
3. "Valve Mechanisms and the Two-Stroke Cycle"
4. "The Fuel System"
5. "The Lubricating and Cooling Systems"

V. B. Fundamentals of Electrical Power

1. "Basic Principles"
2. "Control and Transmission"

C. Fundamentals of Fluid Power

1. "Basic Principles"
2. "Control and Transmission"

D. Introduction to the Diesel Engine

1. "History, Usage, Advantages, Disadvantages"
2. "Operating Principles"

E. Introduction to Power

1. "The Nature and Development of Power"
2. "The Measurement of Power"

F. Motor Troubleshooting, Maintenance, and Steering Assemblies Installation

G. Small Engine Service and Overhaul

1. "Seasonal Servicing: The Small Engine"
2. "Ignition Service"
3. "Fuel Service"
4. "Major Overhaul: Disassembly"
5. "Major Overhaul: Preparing the Internal Parts"
6. "Major Overhaul: Assembling the Internal Parts"

VI. Virginia Department of Education
Audiovisual Services
P.O. Box 6Q
Richmond, Virginia 23216

Note: These films may be ordered, using the computer numbers provided, through the school librarian.

A. Combustion (#38709)
B. Controlling Atomic Energy (#66108)
C. Dams (#59408)
D. Electrical Safety--Living With a Strong, Silent Partner (#73110)
E. Electricity--Handle With Care (#36708)
F. Electrochemical Cells (#97808)
G. Energy From the Sun (#00204)
H. Engines--How They Work (#14805)
I. Fluids in Motion (#42712)
J. Great Search--Man's Need for Power and Energy (#53710)
K. How to Produce Electric Current With Magnets (#34105)
L. Hydraulic Fittings (#71310)
M. Introduction to Reaction Kinetics (#90708)
N. Ionization Energy (#89808)
O. Laws of Conservation of Energy and Matter (#14705)
P. Man in Flight (#51112)

Q. Mechanical Power Transmission--From Muscle to Machine (#77210)
R. Power From Paradise (#29712)
S. Pressure in Fluids at Rest (#63504)
T. Projection 70's--Transportation (#10212)
U. Research by Rockets (#34612)
V. Rockets--How They Work (#41409)
W. Safety With Electricity (#67905)
X. Science for the Space Age--Forces (#88308)
Y. Story of Magnetism (#73608)
Z. Transportation Maintenance (#72005)
AA. We Use Power (#50704)
BB. Work, Time, and Power (#70708)

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